

## **APPENDIX 12—REASONABLY FORESEEABLE DEVELOPMENT SCENARIO FOR OIL AND GAS AND GEOTHERMAL RESOURCES**

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### **OIL AND GAS**

#### **Summary**

Recent exploration and drilling results in the western portion of the Richfield planning area have precipitated much interest in leasing and exploration. During the past 15 years, the area has received little attention as a potential oil and gas area. On the basis of geology, leasing activity, proposed drilling, and a comparison with the history of development in the Northern Utah–Wyoming Overthrust Belt in the 1970s, Bureau of Land Management (BLM) has projected that 360 wells will be drilled in this area during the next 15 years. The ownership pattern in this belt is a mixture of BLM lands, State of Utah lands, and privately owned lands. Each well pad will disturb about four acres and will require about two miles of new roads. Early development activity indicates that multiple wells will be drilled from many pads, with the overall effect of reducing total impacts.

The southern half of the planning area will likely receive much less attention, and only 45 wells are projected for that area (again, with four acre pads and two miles of road per well pad). The remainder of the planning area is the Wasatch Plateau, which is largely national forest. Forty-nine wells are expected in this area, many of which will be coal bed natural gas (CBNG) tests. Each pad will disturb about two acres and require about five miles of road per well.

The other major source of surface disturbance will be geophysical exploration. Most of this is projected to occur in the western part of the planning area and will disturb approximately 4,500 acres, much of which will likely be on privately owned lands. In the Wasatch Plateau area, helicopters will be used in some areas, and disturbance is expected on about 360 acres. Fewer geophysical surveys are anticipated for the remainder of the planning area, and it is estimated that about 240 acres will be disturbed.

It is assumed that any future pipelines, power lines, etc., would follow roads where possible and that continuing reclamation of surface disturbance would reduce net impacts. Future field discoveries, if any, will result in the construction of production facilities and some additional impacts beyond the well pads.

Total surface impacts are estimated to be about 8,180 acres (5,100 acres from geophysical exploration and 3,080 acres from drilling).

#### **Introduction**

The following Reasonably Foreseeable Development Scenario (RFD) projects the level of oil and gas activity that can reasonably be expected during the next 15 years in the planning area. All lands (Federal, State of Utah, and private) are included in the projection, following the guidance in BLM Handbook H-1624-1, *Planning for Fluid Mineral Resources* and Instruction Memorandum No. 2004-089, *Policy for Reasonably Foreseeable Development (RFD) Scenario for Oil and Gas*. It is assumed that all potentially productive areas are open under standard lease terms and conditions, except those areas designated as closed to leasing by law, regulation, or executive order.

Worldwide demand for oil and gas continues to grow and all indications are that growth will continue. Against this background, geology, past and present activity, economics, and other factors will determine the level of activity in the planning area.

## Description of Geology

Geology is the ultimate controlling factor determining future hydrocarbon exploration and development. This discussion will consider the geological differences within the planning area as they relate to oil and gas potential. The basic units considered will be the individual oil and gas “play” (Gautier *et al.* 1996) and “assessment unit” (Schenk *et al.* 2003) as these terms are used by the United States Geological Survey (USGS) in their national assessments of oil and gas resources. The Mineral Potential Report for the Richfield RMP (Booz Allen Hamilton 2004) discusses the geology of the planning area and gives descriptions of most of the plays that are shown in Figure 1 of this report.

The geologically oldest play in the planning area is the Late Proterozoic and Cambrian Play (USGS-2403), which was described in the Northern Arizona Province but includes a large portion of southern and central Utah, including the southern part of the planning area. The play is based on the recognition of carbonaceous shale in the Upper Proterozoic Chuar Group in the Grand Canyon and the projection of these units in the subsurface of northern Arizona and southern and central Utah (Rauzi 1990). Given this potential source rock, there was a potential for hydrocarbons in uppermost Proterozoic and lower Cambrian reservoirs. The play received a great deal of attention in the 1990s, and several test wells were drilled in southern Utah. Some of the wells encountered carbon dioxide gas, but no hydrocarbons were reported and interest in the play waned.

Four classic Paradox Basin plays underlie the extreme eastern corner of the planning area, the area generally east of Range 12 East in easternmost Wayne and Garfield counties. The plays are identified as Buried Fault Blocks (USGS-2101), Porous Carbonate Buildup (USGS-2102), Fractured Interbed (USGS-2103), and Salt Anticline Flank (USGS-2105) (Huffman 1996). Play 2101 is exemplified by the prolific Lisbon Field in northern San Juan County, where oil and gas are produced from Devonian and Mississippian age carbonate rocks and sandstones in a faulted anticline (Smouse 1993). Play 2102 is primarily an oil play, characterized by hydrocarbon accumulations in porous algal mounds and related rocks in the Paradox Formation of the Hermosa Group (Pennsylvanian age). Traps are largely stratigraphic in nature involving porosity and permeability differences in carbonate and evaporitic rocks and organic-rich dolomitic shales. Structures of Pennsylvanian age may have influenced the locations of the algal buildups. The Giant Aneth Field in San Juan County is the largest field in this play, but many other smaller isolated buildups have produced (Huffman 1996).

Play 2103 is a continuous oil and gas play with organic rich dolomitic shales serving as both source and reservoir rocks. Fracturing of the otherwise tight rocks is necessary if the play is to be productive. Dolomitic shales are interbedded with salt in a cyclical sequence, where the salt provides a seal for the fractured reservoirs (Huffman 1996). This play is productive in southwestern Grand County, where current development involves horizontal wells designed to intersect vertical fractures in areas where structures have enhanced fracturing. Play 2105 involves Pennsylvanian and Permian age carbonate and sandstone reservoirs along the flanks of northwest-trending salt anticlines. Production to date has been gas—mostly from Andy’s Mesa Field in Colorado—but the play is lightly explored (Huffman 1996).

The Permo-Triassic Unconformity Play (USGS-2106) was included in the 1995 USGS Assessment of greater Paradox Basin resources even though it is outside the Paradox Basin proper. The Permo-Triassic Unconformity Play includes a large part of the planning area. Known occurrences and shows are in upper Permian and lower Triassic carbonate and sandstone formations. Upper Valley Oil Field south of the planning area produces from this play, and oil and gas shows have been reported over a large area in

southern and central Utah. The trapping mechanism at Upper Valley is anticlinal, but the oil is offset from the crest by a strong hydrodynamic drive. Huffman (1996) described the play as lightly explored and emphasized unanswered questions about source rock and timing.

Two hypothetical Eastern Great Basin Province plays, the Late Paleozoic Play (USGS-1902) and the Sevier Frontal Zone Play (USGS-1907), include western Sevier and Sanpete counties. Both of these plays were nonproductive and hypothetical when first described (Peterson and Grow 1996), but recent drilling has since confirmed the Sevier Frontal Zone Play. Play 1902 is based on the possibility of early-formed traps in middle and upper Paleozoic carbonates and sandstones. Potential source rocks include organic-rich marine shales in Mississippian, Pennsylvanian, and Permian age formations, which may have favorable maturity levels in some areas of the play. A variety of structural and stratigraphic traps may be present, but the play remains hypothetical at this time.

Play 1907 was also hypothetical and was based in large part on similarities in lithology and structural style between this area and productive segments of the Overthrust Belt in northeastern Utah and southwestern Wyoming. Potential traps exist in structures formed along and near the leading edge of Sevier thrust plates, and favorable reservoir rock is present in several formations. Recent drilling has confirmed the presence of oil at one location along this zone, and additional exploration is in progress.

The Cretaceous Sandstone Play (USGS-2107) was also included in the Paradox Basin Assessment (Huffman 1996) although it is outside the geologic boundaries of the basin. This play specifically relates to gas occurrences in sandstone reservoirs in the Wasatch Plateau. Currently, there is interest, not so much in the sandstone reservoirs, but in coal beds within the sandstones (e.g., for CBNG). The most productive coals have been in the Ferron Sandstone Member of the Mancos Shale in Carbon and Emery counties. Similar coals in the Emery Sandstone in the Wasatch Plateau are prospective targets. Both of these units extend into the planning area in the Wasatch Plateau area. The CBNG resource was evaluated in more detail in the 2003 USGS Assessment, although the area of interest coincides with that of Play 2107.

The USGS completed a new assessment of oil and gas resources in the Uinta-Piceance Province in 2003 and included the Wasatch Plateau and the Ferron Trend in the analysis. Parts of both of these regions extend into the planning area. The Uinta Basin Blackhawk Formation Coalbed Gas Assessment Unit (USGS-AU 50200281) evaluates CBNG resources in the Blackhawk and Emery Sandstone coals in the Book Cliffs and Wasatch Plateau. CBNG production from Blackhawk coals has been established in the Castlegate Field in northern Carbon County, but production has been hampered by problems with dewatering the coal. There are also coal beds in the Emery Sandstone in the Wasatch Plateau in Carbon, Sanpete, and Sevier counties, which may have favorable maturity levels in some areas (Johnson and Roberts 2003).

Five assessment units (USGS-AU 50200161, AU 50200183, AU 50200184, AU 50200185, and AU 50200101) of the Ferron/Wasatch Plateau Total Petroleum System are partially or wholly in the northeastern part of the planning area. More than 30 wells have been drilled in these assessment units, with only one listed as productive; however, no volumes are listed (Henry and Finn 2003, p. 26). All of these wells were based on the known occurrence of coal beds in the Ferron Sandstone Member of the Mancos Shale. All of these gas assessments units are included within the area covered by the Cretaceous Sandstone Play (USGS-2107).

## **Past and Present Oil and Gas Activity**

### **Geophysical Exploration**

Richfield Field Office (RFO) records indicate that approximately 90 authorizations for geophysical surveys were issued during the period from 1972 to the present in the western parts of the planning area (the old Sevier River Resource Area). Sixty-five of these were issued between 1976 and 1982, with only four issued after 1988. The surveys resulting from the permits were spread over most of the western part of the planning area.

Fewer surveys, of unknown dates, have been conducted in the eastern part of the planning area (eastern Wayne and Garfield counties) with a concentration in and around T. 30 S., R. 12 E. on the line separating the two counties. Several nonproductive wells have been drilled in this same area.

Since 2004, there has been an increase in interest in acquiring geophysical data in the vicinity of Sevier Valley related to the recent discovery of oil. One large project (115 miles) was completed in 2004, and additional proposals by multiple companies are anticipated.

### **Federal Oil and Gas Leasing**

Significant portions of Sanpete and Sevier counties are currently under Federal lease (See Table 2 of the Mineral Potential Report for the Richfield RMP [Booz Allen Hamilton 2004]). Leases are clustered in the western and eastern parts of the two counties, with most of the eastern leases located in the Manti-La Sal National Forest and related to the Sevier Frontal Play and the Cretaceous Sandstone and CBNG plays, respectively. There are very few leases in the Fishlake National Forest, including the southern part of the Wasatch Plateau. Another block of leases covers the eastern part of the planning area in eastern Wayne and Garfield counties. This latter group is combined hydrocarbon lease conversions in the Tar Sand Triangle Special Tar Sand Area (STSA).

The largest Federal lease sale involving lands in the planning area occurred in June 2004. In this sale (the June 25, 2004, BLM Competitive Oil and Gas Lease Sale) 81 parcels, encompassing 146,365 acres in the planning area, were offered for lease. Several of the tracts in the western part of the area received bonus bids of more than \$100 per acre, with a maximum bid of \$360 per acre indicating strong industry interest in this area. The lease tracts extend northward from southwestern Sevier County through western Sanpete County. This area of interest coincides with the Sevier Frontal Zone Play (USGS-1907) described above. Another block of pending leases in northeastern Wayne County resulted from the November 2003 and June 2004 lease sale, but these were obtained for the minimum bonus bid (\$2.00 per acre) or noncompetitively the day after the sale.

### **Oil and Gas Units**

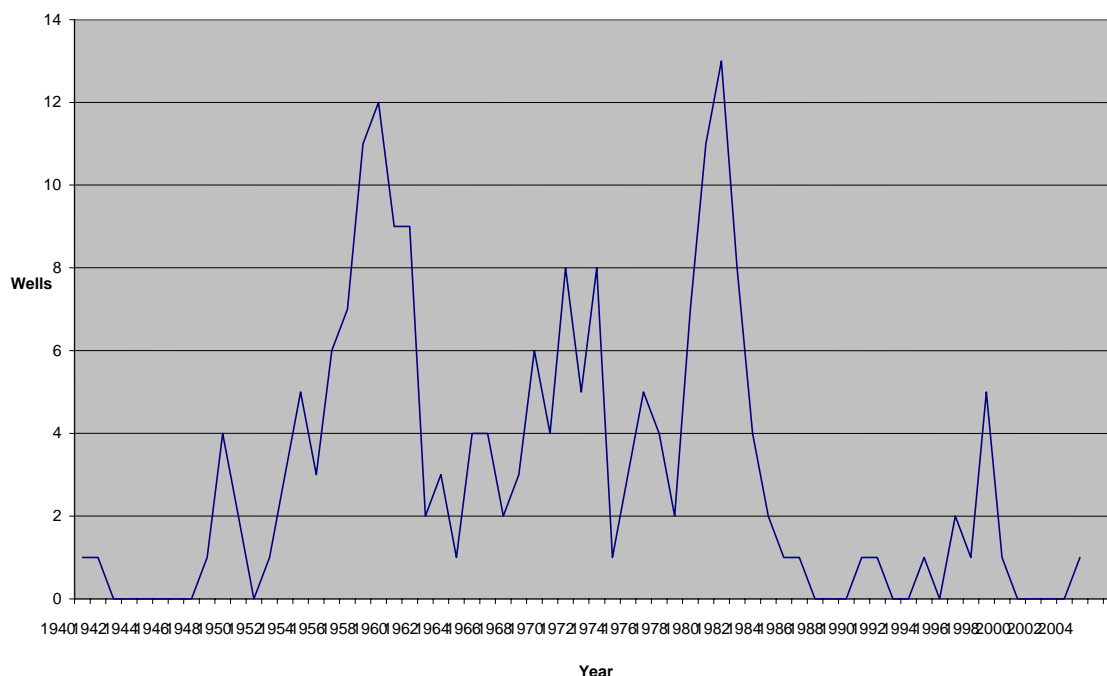
Wolverine Gas and Oil established the Wolverine Unit in June 2003. The Unit Area includes 65,980 acres of Federal, State, and private lands in Sevier and Sanpete counties. The first unit obligation well was completed in 2004, and additional wells are currently permitted. There were no other exploration units in the planning area as of February 2005.

### **Historical Drilling and Production**

Altogether, approximately 220 exploration wells have been drilled in the planning area (IHS Energy Well Data 2004). Thirteen of these were drilled during the 1990–2004 period, yielding an average of 0.9 new wells per year. Drilling activity peaked in the late 1950s (12 wells per year) and again in the early 1980s

(13 wells per year). For the period 1940–2004, the average number of wells drilled each year was slightly over three (see Figure 1).

Figure 1. Wells Drilled/Year (1940-2004)



Utah Division of Oil, Gas, and Mining production data (February 2004) lists only 405 barrels of oil and 3,027,708 thousand cubic feet (mcf) of gas for Sanpete County, with 3,027,183 mcf being from the abandoned Joe's Valley Field. The source of the remaining 525 mcf of gas and 405 barrels of oil is not given. No other historical production is listed for the planning area, and Joe's Valley is the only identified field.

Oil production in the Covenant Field, associated with the Wolverine Unit, began in 2004. Production quantities are not available at this time.

## Infrastructure

The Kern River gas pipeline parallels the western boundary of the planning area at a distance of two to five miles. This pipeline was built in 1991 and expanded in 2003 to transport natural gas from southwestern Wyoming and Utah to markets in southern Nevada and California. A Questar pipeline follows Highway 89 through the planning area. No oil pipelines are within this part of the State, and if oil is produced, it would probably be trucked to Salt Lake City as has been done for 40 years with oil produced in the Upper Valley Field.

## Oil and Gas Occurrence Potential

The Mineral Potential Report for the Richfield RMP (Booz Allen Hamilton 2004) describes oil and gas occurrence potential and includes maps depicting occurrence potential ratings.

## Potential for Oil and Gas Activity

In the following discussion, the term “oil and gas activity” will be used instead of “development” to avoid possible confusion between “exploration” and “development” in the strict sense. There is only one known field in the planning area at this time, and many of the future wells will be exploratory in nature. The purpose of the RFD is to arrive at a reasonable estimate of surface impacts resulting from all future oil and gas activity, whether this results from exploration or from development activity. Future activity levels will be determined largely by the outcome of continuing testing of the Sevier Frontal Zone Play (USGS-1907) and the gas resources in the Wasatch/Ferron and Mesaverde Blackhawk assessment units, essentially the area covered by Play. Energy demand will likely only increase in the future, and if additional economically recoverable resources can be identified in the Sevier Frontal Zone Play and the area covered by Play 2107, significant activity may occur. Other plays would seem to be less promising but will probably continue to be tested periodically. Activity levels will be projected by play, or overlapping groups of plays, and then related to geographic subdivisions in the planning area.

The northwestern corner of the Paradox Basin underlies the extreme eastern portion of Garfield and Wayne counties and includes four partially overlapping plays: 2101 (Buried Fault Blocks), 2102 (Porous Carbonate Buildup), 2103 (Fractured Interbed), and 2105 (Salt Anticline Flank). These plays have been tested by several wells, and it is unlikely that significant drilling will occur there in the next 15 years (although a few tests can be expected). Huffman (1996) gave the following assessment of Plays 2101, 2102, 2103, and 2105 for the Paradox Basin as a whole: Play 2101—low to moderate future potential for small to medium-sized fields with minimal oil columns; Play 2102—small fields in the 1–3 million barrels of oil range; Play 2103—greatest potential in the Cane Creek, Chimney Rock, Gothic, and Hovenweep Shales due to organic content and thickness; and Play 2105—low potential for oil, fair to good for gas. Several horizontal wells have produced from Play 2103 in the Kane Springs Unit Area in Grand County southeast of the planning area, but the wells are expensive and production rates declined fairly rapidly.

Plays 2106 (Permo-Triassic Unconformity) and 2403 (Upper Proterozoic Cambrian) underlie large areas in the southern and central parts of the planning area. The northern and western parts of these plays have encountered carbon dioxide gas, and the Paleozoic age rocks of this entire region appear to have been flushed by carbon dioxide generated by igneous activity to the north (Utah Geological Survey 2004). Hydrocarbons may still be present in these reservoirs in the eastern and southern parts of the planning area. In the Upper Valley Oil Field (USGS-2106), near Escalante, a strong hydrodynamic drive has offset the oil onto the flank of an anticlinal structure, and other anticlinal flanks will probably be tested. Huffman (1996) described Play 2106 as lightly explored and projected a low probability of any significant exploration effort until source rock and timing questions were answered.

Two hypothetical Eastern Great Basin plays (USGS-1902 and USGS-1907) cover western Sevier and Sanpete counties. Play 1907 is characterized by structures along the leading edge of Sevier age faults analogous to those productive in the Wyoming Thrust Belt to the north (Peterson and Grow 1996). Several test wells were drilled in this play in the 1970s, but it had received little attention in recent years until Wolverine Gas and Oil established the Wolverine Unit in 2003. Wolverine Gas and Oil has now completed two wells, with oil production reported from the Navajo Sandstone (*The Rocky Mountain Oil Journal*, vol. 84, no. 27, July 2004; Moulton and Pinnell 2005), and is drilling additional wells while acquiring additional two dimensional seismic data. Parcels within and near this play received large bonus bids at the June 2004 BLM lease sale indicating renewed industry interest. Exploration wells will probably be located at different locations along the north-trending play, and if exploration is successful, this will be followed by development wells. Multiple wells are projected from many drill pads, which will minimize surface disturbance.

Much of the land in this play is privately owned, but a block of BLM land in and around Ts. 17 & 18 S., R. 1E. is unleased and would attract a great deal of industry interest if offered for competitive bidding. Other larger blocks of BLM lands are under lease, and the lands mentioned above appear to be the only BLM lands where a lack of leases would be an impediment to exploration and development.

Continuing evaluation of coals and their including sandstones for gas resources can be expected in eastern Sanpete and Sevier counties. The Uinta Basin Blackhawk Coalbed Gas Assessment Unit (AU 50200281) covers parts of three field offices, with approximately 45% of the assessment unit located in the planning area. The USGS's estimated mean value for total technically recoverable CBNG in the unit is 499 billion cubic feet (BCF) in the Blackhawk and Emery coals. If it is assumed that the resource is more or less evenly distributed throughout the assessment unit, however questionable this assumption might be, the planning area could contain 225 BCF of this CBNG. Tabet and Quick (2003, p. 10) estimated that the Emery coals under the Wasatch Plateau might contain an in-place gas resource of 0.8 to 3.2 trillion cubic feet (TCF). It appears that roughly 60% of the area included in these authors' estimate (or 0.5–1.9 TCF of CBNG) lies in the planning area. How much recoverable gas is present remains to be determined, but certainly there will be continuing interest in the CBNG resource in this part of the planning area. These potential resources are in the Wasatch Plateau portion of the planning area, within the Manti-LaSal and Fishlake National Forests. Existing leases already cover significant portions of the Manti-La Sal National Forest in eastern Sanpete County. However, leasing is not allowed under the current Fishlake National Forest Plan unless an environmental analysis is completed for specific leasing proposals. Until a new forest plan is developed, the absence of leasing is an impediment to exploration and development in this national forest.

Several assessment units of the Ferron/Wasatch Plateau Total Petroleum System are partially or completely in the planning area in eastern Sanpete and Sevier counties. These units include Deep Coal and Sandstone Gas (AU 50200161), Southern Coal Fairway (AU 50200183), Joe's Valley and Musinia Grabens (AU 50200184)<sup>3</sup>, and Southern Coal Outcrop (AU 50200185). The "EPCA" Inventory, prepared under a provision of the 2000 Energy Policy and Conservation Act (U.S. Departments of the Interior, Agriculture, and Energy 2003, pp. 2–14), assigns undiscovered technically recoverable resources of 223 BCF of gas to these assessment units.<sup>2</sup> Prorating these numbers according to area shows 173 BCF of gas in the planning area. Again, most of this resource lies under the Manti-LaSal and Fishlake National Forests, but a narrow strip of BLM land in extreme eastern Sevier County could contain some gas.

The gas content of the Ferron coals appears to decrease southward from the Drunkards Wash Field in Carbon County (Lamarre 2001, Utah Geological Survey 2004), and Nuccio and Roberts (2003, p. 32) show vitrinite reflectance values of less than 0.60 at the base of the Mancos Shale in much of the eastern and southern parts of the Wasatch Plateau. Higher values are indicated for parts of the northwestern Plateau in Sanpete County. These data suggest that the potential for CBNG occurrence in the Fishlake National Forest is less than the potential in the Manti-LaSal National Forest.

In addition to the coals, gas in conventional sandstone reservoirs in the same stratigraphic sequence may be tested. This area of moderate activity potential is generally the area of Play 2107.

Coal beds are known to occur in rocks of Cretaceous age in the Henry Mountains Basin in northern Garfield and southern Wayne counties in the eastern part of the planning area. The presence of these coals raises the possibility of CBNG activity in the basin. Coal occurs in three formations, in ascending order: the Dakota Sandstone, the Ferron Sandstone, and the Muley Canyon Sandstone. The thickest and most continuous coals are in the Muley Canyon Sandstone, with the other two zones containing thinner

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<sup>2</sup> AU 50200184 was not assessed by the USGS.

and less continuous beds (Law 1980, p. 326). No information is available on the gas content of the coal, and the USGS has not produced an assessment of the potential resource. In many areas, the Muley Canyon coal is at or near the surface, often exposed on the tops and flanks of mesas. The coal bearing rocks are deeper in the southwestern part of the basin, which may provide some potential for CBNG retention. No oil and gas leases currently exist in the Henry Mountains Basin.

The greatest potential for oil and gas activity appears to be in Sevier and Sanpete counties within the Sevier Frontal Zone Play (USGS-1907) and in the Wasatch Plateau area of these same two counties (gas in Cretaceous coals and sandstones). This potential is rated as high in the Sevier Frontal Zone Play and moderate in the northern part of the Wasatch Plateau, decreasing toward the southwest. Less activity is predicted in the remaining parts of the planning area, but exploration wells will probably continue to be drilled at near the historical rate (0.9 to 3.12 per year) if oil and gas prices remain at current levels or increase, as is generally expected.

## **RFD Baseline Scenario Assumptions and Discussion**

In developing the baseline scenario it was assumed that all potentially productive areas are open under standard lease terms and conditions, except those areas designated as closed to leasing by law, regulations, or executive order. The largest block of excluded lands would be the wilderness study areas (WSAs), but most of these are in areas where the potential for activity is low.

Long-term well completion rates for 1940–2004 have averaged slightly more than three wells per year. When only the past 15 years (1990–2004) are considered, the rate drops to slightly less than one well per year (IHS Well Data 2004). Recent interest in parts of the planning area indicates that activity during the next 15 years will be considerably higher than that for either of these intervals.

For purposes of estimating the number of wells to be drilled during the next 15 years, the planning area has been divided into four geographic areas, defined by USGS plays and assessment units. These are (1) the eastern portion of Wayne and Garfield counties (generally east of R. 12 E.), which is underlain by true Paradox Basin plays (USGS-2101, USGS-2102, USGS-2103, and USGS-2105); (2) the southern part of the planning area, as defined by the Permo-Triassic Unconformity Play (USGS-2106); (3) the Wasatch Plateau, defined by the Cretaceous Sandstone Play (USGS-2107), but also including CBNG in the Ferron, Emery, and Blackhawk coals; and (4) the area from the eastern boundary of the Sevier Frontal Zone Play (USGS-1907) to the western boundary of the planning area.

Potential for activity in Areas (plays included in each area are listed in Table A12-1) 1 and 2 (entire southern part of the planning area) is considered to be low, as noted above. Exploration in these areas is expected to continue at near historic rates (considered to be three wells per year). This would produce 45 wells during the projection period (15 years).

Activity levels in Area 3 are expected to be higher because of the existence of coal in the Ferron, Emery, and Blackhawk formations, as well as conventional sandstone reservoirs. The Utah Geological Survey (2004, p. 38) projects four CBNG wells for the Fishlake National Forest during the next 15 years, and this number will be used here for the southern part of the Wasatch Plateau. Potential for drilling activity on the northern part of the plateau (Manti-La Sal National Forest) is considered to be higher, as discussed above. In the northern part of the plateau, 45 wells (three per year) are projected, resulting in a total of 49 wells in Area 3 during the next 15 years.

The Sevier Frontal Zone Play (USGS-1907) and adjacent areas in western Sevier and Sanpete counties are expected to be the focus of activity during the life of the plan. At the time of this report, two wells have been completed in the Covenant Field of the Wolverine Unit. Seven additional, collocated wells are



currently permitted. Moulton and Pinnell (2005, p. 42) anticipate six or more additional wells along the play by mid-2005. This would result in a total of at least 13 wells for the first half of 2005.

Play 1907 is geologically similar to the Utah-Wyoming Overthrust Belt, which was the site of major exploration and development in the 1970s, but includes a larger area than the productive area around the Pineview Field (Moulton and Pinnell 2005). This central Utah thrust belt overlaps the hypothetical Late Paleozoic Play (USGS-1902), and the thrust play (USGS-1907) is extended to the western boundaries of Sevier and Sanpete counties. Moulton and Pinnell (2005) seem to concur, showing a lease area, related to this thrust play, extending west of the Sevier and Sanpete county lines. Leases in this area commanded high bonus bids at the June 2004 BLM lease sale. If the analogy holds true, we can expect exploration activity along the length of the play, followed by field development around discoveries. Moulton and Pinnell (2005, p. 42) reported that, during the five years after the 1975 discovery of the Pineview Field in northern Utah, 175 wildcat wells were drilled, leading to the discovery of 11 new fields. This averages 16 wildcat wells drilled for each field discovered. The course of development for the Pineview Field area may provide an indication of what will occur in western Sevier and Sanpete counties.

Additional data on the Utah-Wyoming Overthrust Belt indicates that between 1976 and 1997 a total of 485 wells were drilled (Vrona, personal communication, 2005). One hundred thirty-one (27%) of these wells were completed as dry holes. This equates to a rate of 24 wells drilled per year; and if this drilling rate is projected for Area 4, a total of 360 wells would be drilled during the next 15 years.

Table A12-1 provides a summary of these estimates for each area.

**Table A12-1. Number of Wells by Area**

Area	Number of Wells
Combined Areas 1 and 2 <sup>a</sup>	45
Area 3 <sup>b</sup>	49
Area 4 <sup>c</sup>	360
<b>Total</b>	<b>454</b>

<sup>a</sup> Plays 2101, 2102, 2103, 2104, 2105, 2106, and 2403.

<sup>b</sup> Play 2107.

<sup>c</sup> Plays 1907 and 1902.

Most of the 45 wells in Areas 1 and 2 will probably be on BLM lands. The northern part of Area 3 is in the Manti-La Sal National Forest, and the southern part is in the Fishlake National Forest; therefore, all of the 49 projected wells for this area are likely to be on National Forest lands. Area 4 (USGS-1907) contains a mixture of BLM, State, and private lands; however, State acreage is much less than BLM and private holdings, which are approximately equal in proportion. The 360 wells in Area 4 are expected to be divided between Federal and private lands. Overall, 10% of the wells are projected to be on national forest lands; 45% on BLM lands; 5% on State lands; and 40% on private lands.

This projection should not be considered a ceiling for permitting additional wells. Any upper limit on drilling should be based on total surface disturbance and should consider ongoing reclamation, drilling multiple wells from a single pad, and other factors.

## **SURFACE DISTURBANCE DUE TO OIL AND GAS ACTIVITY ON ALL LANDS**

### **Oil and Gas**

#### **Geophysical Surveys**

Future surface disturbance will result largely from geophysical surveys and drilling (and associated access). The Utah Geological Survey (2004) projected that approximately 625 line miles of geophysical surveys would be required in the 1,250 square miles of prospective lands in the Fishlake National Forest. Area 3 is approximately this size; thus, using the above ratio of line miles to square miles, approximately 600 line miles can be projected for the planning area portion of the Wasatch Plateau. Also following the Utah Geological Survey's Fishlake estimates, about 50% of the surveys would be buggy mounted and 50% would be conducted by helicopter, resulting in approximately 300 line miles for each type of disturbance. The Utah Geological Survey (2004) estimates that buggy-mounted surveys disturb 1.2 acres per line mile, whereas helicopter-conducted surveys disturb only 0.007 acre per line mile.

On the basis of these projections, the total disturbance would be  $(300 \times 1.2) + (300 \times 0.007) = 360 + 2.1 = 362.1$  acres (rounded to 360 acres).

Approximately 1,260 square miles of Play 1907 lies within the planning area, but leasing interest covers a somewhat larger total area. Since the discovery of the Covenant Field, several lessees have expressed interest in obtaining permits for geophysical exploration on BLM lands. Interest in geophysical surveys on private lands in the play area will increase in a similar manner. At this point, it is not clear how much of the work will be conducted by buggy and how much by helicopter, nor is it clear how much will be 2-D and how much will be 3-D. Some surveys will probably be conducted by vibroseis. Early discussions indicate that BLM can expect several hundred miles of seismic surveys during the next few years on BLM and private lands. BLM is estimating an average of 250 miles of survey per year over the 15-year period under consideration. Activity may exceed this average in the near future but is likely to decrease later in the cycle. If most of the surveys are buggy mounted, the total disturbance in Area 4 is likely to be **4,500 acres** (3,750 miles  $\times$  1.2 acres/mile).

Few surveys are expected in the remaining parts of the planning area (Areas 1 and 2) based on past activity and current interest. A total of 200 miles of geophysical surveys is proposed for the 15-year time period, resulting in **240 acres** of disturbance in these areas.

On the basis of these projections, the total surface disturbance expected from **geophysical surveys in the planning area would be  $360 + 4,500 + 240 = 5,100$  acres.**

#### **Wells**

Forty-nine wells are projected for Area 3 (Wasatch Plateau). The Utah Geological Survey (2004) assumed a drill pad of size of two acres and five miles of road (4 acres of disturbance per mile) for each well in the Fishlake National Forest. Using these values, the 49 projected wells would impact approximately **1,100 acres**.

Areas 1, 2, and 4 are projected to contain 405 wells overall. For Area 4, many of these wells would probably be directional wells from a single drill pad. Based on the projection of 360 wells for this area, with an average of three wells per pad, the number of well pads for Area 4 is projected at 120. The 45 wells in Areas 1 and 2 are assumed to be single well pads (one well per pad). Thus, the total number of

pads for the three areas is projected at 165. Assuming a pad size of four acres plus two miles of road (with four acres of disturbance per mile) would result in a projected surface disturbance of **1,980 acres**.

On the basis of these projections, the total surface disturbance in the planning area from **drilling 454 wells would be  $1,100 + 1,980 = 3,080$  acres**.

## **Summary**

**Total surface disturbance for the planning area from all oil and gas activity (geophysical surveys and wells) is projected at  $5,100 + 3,080 = 8,180$  acres.**

The disturbance estimated above will be future disturbance during the 15 year life of the plan. Current disturbance is minimal, and areas of past disturbance have largely been reclaimed. Disturbance associated with future nonproductive wells should be reclaimed within three to four years after a well has been plugged and abandoned.

## **TAR SANDS**

The unconventional resource contained in the Tar Sand Triangle STSA received considerable industry interest in the late 1970s and early 1980s. Applications were received to convert existing oil and gas leases to combined hydrocarbon leases under the terms of the Combined Hydrocarbon Leasing Act of 1981. An environmental impact statement (EIS) was begun by BLM and the National Park Service to consider the applications, but this was never completed and the conversions are still pending. No wells are projected for exploration or development, because of the unfinished EIS, the uncertain future of oil sand as an economic resource, and the belief that any proposed activity would not follow conventional oil and gas techniques and would be better considered in a site-specific National Environmental Policy Act (NEPA) document.

## **STATEMENT OF QUALIFICATIONS**

This RFD was prepared by James Fouts, Geologist in the Utah BLM State Office. Mr. Fouts has B.S., M.S., and Ph.D. degrees in geology and has worked for Shell Oil Co., Essex International Corporation, Auburn University, the U.S. Bureau of Mines Salt Lake City Research Center, the U.S. Geological Survey, the U.S. Minerals Management Service, Westminster College, and Salt Lake City Community College.

## REFERENCES

- BLM, 2004, Richfield Field Office Records.
- BLM, 2004, Utah State Office Records.
- BLM, Utah State Office, Geothermal Files.
- Booz Allen Hamilton, 2004, Mineral Potential Report for the Richfield RMP.  
<http://www.blm.gov/rmp/ut/richfield/documents.htm>.
- Brook, C. A., R. H. Mariner, D. R. Mabey, J. R. Swanson, M. Guffanti, and L. J. P. Muffler, 1979, Hydrothermal Convection Systems with Reservoir Temperatures >90 degrees C *In* Muffler, L. J. P., ed., *Assessment of Geothermal Resources of the United States B 1978*, U.S. Geological Survey Circular 790, pp. 18–85.
- Doelling, H. H., and R. L. Graham, 1972, *Eastern and Northern Utah Coal Fields*, Utah Geological and Mineralogical Survey Monograph No. 2, 411 pages.
- Gautier, D. L., G. L. Dalton, K. I. Takahashi, and K. L. Varnes, 1996, *1995 National Assessment of United States Oil and Gas Resources—Results, Methodology, and Supporting Data*, U.S. Geological Survey Digital Data Series DDS-30, release 2.
- Henry, M. E., and T. M. Finn, 2003, Petroleum Assessment of the Ferron/Wasatch Total Petroleum System, Upper Cretaceous Strata, Wasatch Plateau, and Castle Valley, Utah *In* U.S. Geological Survey Assessment Team, compilers, *Petroleum Systems and Geologic Assessment of Oil and Gas in the Uinta-Piceance Province, Utah and Colorado*, U.S. Geological Survey Digital Data Series DDS 69-B, version 1, CD-ROM., 39 pages.
- Huffman, A. C., 1996, Paradox Basin Province (021) *In* Gautier, D. L., G. L. Dalton, K. I. Takahashi, and K. L. Varnes, compilers, *1995 National Assessment of United States Oil and Gas Resources—Results, Methodology, and Supporting Data*, U.S. Geological Survey Digital Data Series DDS 30, release 2, unpaginated.
- Hulen, J. B., and S. M. Sandburg, 1981, *Exploration Case History of the Monroe KGRA, Sevier County, Utah*, Earth Science Laboratory/University of Utah Research Institute Report No. DOE/ID/12079-22, 82 pages.
- IHS Energy Well Data, 2004, CD-ROM.
- Johnson, R. C., and S. B. Roberts, 2003, The Mesaverde Total Petroleum System, Uinta-Piceance Province, Utah and Colorado *In* U.S. Geological Survey Assessment Team, compilers, *Petroleum Systems and Geologic Assessment of Oil and Gas in the Uinta-Piceance Province, Utah and Colorado*, U.S. Geological Survey Digital Data Series DDS 69-B, version 1, CD-ROM, 63 pages.
- Law, B. E., 1980, Tectonic and Sedimentological Controls of Coal Bed Deposition Patterns in Upper Cretaceous Emery Sandstone, Henry Mountains Coal Field, Utah *In* Picard, M. D., editor, *Henry Mountains Symposium*, Utah Geological Association Publication No. 8., 388 pages.
- Mabey, D. R., and K. E. Budding, 1987, *High-Temperature Geothermal Resources of Utah*, Utah Geological and Mineral Survey Bulletin No. 123, pp. 34–40.
- Moulton, F. C., and M. L. Pinnell, 2005, Stunning Utah Oil, Gas Discovery Focuses Spotlight on Hingeline, *Oil and Gas Journal*, January 17, 2005, pp. 42–49.

- Peterson, J.A., and J. A. Grow, 1996, Eastern Great Basin Province *In* Gautier, D. L., G. L. Dalton, K. I. Takahashi, and K. L. Varnes, compilers, *1995 National Assessment of United States Oil and Gas Resources-Results, Methodology, and Supporting Data*, U.S. Geological Survey Digital Data Series DDS 30, release 2, unpaginated.
- Rauzi, S. L., 1990, *Distribution of Proterozoic Hydrocarbon Source Rock in Northern Arizona and Southern Utah*, Arizona Oil and Gas Conservation Commission Special Publication No. 5, 38 pages.
- Schenk, C. J. et al., 2003, *Petroleum Systems and Geologic Assessment of Oil and Gas in the Uinta-Piceance Province, Utah and Colorado*, U.S. Geological Survey Digital Data Series DDS-69-B.
- Smouse, D., 1993, Lisbon *In* Hill, B. G., and S. R. Bereskin, eds., *Oil and Gas Fields of Utah*, Utah Geological Association Publication No. 22, unpaginated.
- Tabet, D. E., and J. C. Quick, 2003, *Frontier Areas for Coalbed-Gas Exploration in Utah*, Utah Geological Survey, Survey Notes, vol. 35, no. 2, pp.10–11.
- United States Departments of the Interior, Agriculture, and Energy, 2003, *Scientific Inventory of Onshore Federal Lands' Oil and Gas Resources and Reserves and the Extent and Nature of Restrictions or Impediments to their Development*.
- Utah BLM sale nets \$9.9 million; Hingeline acreage draws heavy interest—Salt Lake City, UT, *The Rocky Mountain Oil Journal*, 2004, vol. 84, no. 27, p. 1.
- Utah Division of Oil, Gas and Mining, 2004, Web site.
- Utah Geological Survey, 2004, *The Oil, Coalbed Gas, Carbon Dioxide, and Geothermal Resources of the Fishlake National Forest, Southwestern Utah*, 63 pages.
- Vrona, J., 2005, Historical Development of the Wyoming Utah Overthrust Belt, written communication.